Resistance in *Digitaria* to Yellow Sugarcane Aphid, *Sipha flava* (Forbes) as Related to Temperature and Rainfall[1, 2]

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INTRODUCTION

Few of the 51 species of aphids reported from Puerto Rico are considered to be of economic importance in crop production (16). The yellow sugarcane aphid, *Sipha flava* (Forbes), has been reported from Puerto Rico for over 75 years (9). This aphid now is considered to be one of the more important insects in the Island (12,13); during the past decade it has become a pest of major economic importance in sugar production.

Damage to Pangola grass, *Digitaria decumbens* Stent, by the sugarcane aphid has been reported from Florida (1), Puerto Rico (12,13,14), and the U.S. Virgin Islands (15). This aphid species is considered one of the most injurious pasture insects in peninsular Florida (6), where losses up to 75 percent in protein content are reported in moderately infested grass (4). Heavy aphid infestations reduce the phosphorus, iron, and magnesium content of Pangola grass (4). Allen and Boyd (1) emphasized the continued seriousness of the pest in Florida in 1959 which resulted in drastic curtailment of Pangola grass plantings in the Everglades. The extent of damage caused by the aphid in reduced yields and lowered quality forage in terms of economic losses is not known.

Pangola grass acreage has increased rapidly since its introduction into Puerto Rico in the late 1940's where it serves as an excellent alternate host for the sugarcane aphid. Although it is common knowledge that this insect constitutes a serious pasture pest in Puerto Rico, investigations of its damage to pasture grasses have not been made. The description, mode of reproduction, life cycle, seasonal occurrence, nature of damage, host plants, and control, both biological and chemical, of the sugarcane aphid have been reported (2,5,7,8,11,12,13).

The infestation of Pangola grass by the aphid under field conditions is

[1] Manuscript submitted to Editorial Board November 30, 1970.

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The cooperation of the Mayagüez Campus of the University of Puerto Rico in this investigation is acknowledged. Mr. E. James Koch, Biometrial Services Staff, ARS, USDA, Beltsville, Md., provided assistance in the statistical analysis.

influenced by climatic, seasonal changes, cultural and utilization practices, and presence and effectiveness of predators. Infestations recur annually; the severity of infestation follows a general pattern throughout the year in Puerto Rico (10,12). Prolonged droughts during the spring and autumn are conductive to heavy infestations (12,17). Incidence and intensity of infestation is influenced by rainfall patterns and by seasonal changes in subtropical peninsular Florida. The aphid occurs in Florida pastures about mid-October; populations peak in early December and almost disappear after the first killing frost (3).

Control of the sugarcane aphid on tropical crops is a problem. Biological control appears to be ineffective for heavy infestations whether on sugarcane (12) or Pangola grass (5). Genung (5) reports biological control of the aphid is ineffective, even on fairly heavily infested Pangola grass. An entomogenous fungus is reported to be an effective control for the aphid on sugarcane during the wet season if humidity is maintained at high levels for sustained periods (12,18).

The ineffectiveness of biological control and inability to control rainfall necessitates chemical control measures be recommended and used. Insecticidal control of the aphid has been reported for Pangola grass (7,11). Practical and effective control of the aphid on Pangola grass in Florida is achieved by grazing infested grass with large numbers of cattle to remove the forage rapidly rather than use insecticides (8). A consensus among sugarcane growers in Puerto Rico is that rainfall constitutes a major factor in aphid control. Medina-Gaud et al. (12) indicate rainfall is efficient as a control measure only when it occurs at the right time and is accompanied by high temperature and humidity. Rainfall during the cool winter months usually is not considered to be of consequence unless it is sufficiently heavy to suppress the buildup of insect infestations (13).

The difficulty and expense encountered in continuous aphid control in Pangola grass emphasize the need for aphid-resistant germ plasm in *Digitaria*. The object of this study is to screen *Digitaria* introductions in the search for aphid-resistant germ plasm.

MATERIALS AND METHODS

Selected germ plasm of the *Digitaria* collection, maintained by Southern Regional Plant Introduction Station, Experiment, Ga., is under evaluation by the U.S. Soil Conservation Service at Mayagüez, Puerto Rico. Plant materials used in this study are being maintained by SCS Plant Materials Facility at this location.

Five *Digitaria* species, including one subspecies, and Pangola grass, the control, were evaluated in field plots for resistance to sugarcane aphid. They include *D. milanjiana* (Rendle) Stapf, *D. milanjiana* subsp. *eylesiana*

Henr., *D. pentzii* Stent, *D. setivalva* Stent, *D. smutsii* Stent, and *D. valida* Stent. Vegetative material, used as propagating stocks, was planted in rows in February 1966, with sufficient space among rows to permit ample growth without the grasses becoming intermixed. The species were randomized in rows in a non-replicated experiment. The grass received 74 kg. of 14-4-10 fertilizer and 37 kg. N/ha. the first year, which was applied in equal applications semi-annually. No fertilizer was used the second year of the trial and no grass was removed during the trial period as any form of forage removal is thought to influence the incidence and degree of insect infestation.

Visual observations of infestation were made and recorded at approximately 3-week intervals beginning in April 1966 and ending in December 1967. The 3-week schedule was selected based on the known life cycle of the insect under local conditions. The interval between observations allowed visible changes in infestation to become readily discernible. Visual estimates of infestation were made and a rating of 1, 3, 5, 7, and 9 was used: 1 = 0–20%, 3 = 20–40%, 5 = 40–60%, 7 = 60–80%, and 9 = 80–100% infestation.

TABLE 1.—*Resistance among* Digitaria *species to the yellow sugarcane aphid,* Sipha flava (*Forbes*)

Species	Clones	Resistance rating[1]	
		Range	Mean
	Number		
D. valida Stent	30	2.7–6.0	4.8 a[2]
D. milanjiana (Rendle) Stapf	28	1.6–5.8	4.6 b
D. milanjiana subsp. *eylesiana* Henr.	27	3.1–5.8	4.5 b
D. setivalva Stent	16	2.2–5.3	4.2 c
D. smutsii Stent	12	1.8–5.3	3.5 d
D. pentzii Stent	24	1.2–5.6	3.4 d
Mean	137		4.3

[1] Percentage infestation: 1 = 0-20%, 3 = 20-40%, 5 = 40-60%, 7 = 60-80%, 9 = 80-100%.

[2] Means are significantly different at 5-percent level by Duncan's Multiple Range if not followed by any letters in common.

RESULTS AND DISCUSSION

Significant differences exist among *Digitaria* species for resistance to sugarcane aphid (table 1). *Digitaria pentzii* and *D. smutsii* are superior in insect resistance and *D. valida* is inferior (table 1). Comparisons of the average performance of species are essential in initial screening programs but provide only broad outlines in identifying superior germ plasm. More specific and valuable information is obtained by assessing the performance of individual clones within species.

Differential insect resistance exists among clones within species. The resistance rating for P.I. 299655 of *D. milanjiana* is superior to 27 other clones of the species under evaluation. Outstanding resistant clones of *D. milanjiana* subsp. *eylesiana* include P.I. 299708 and P.I. 299710 and those of *D. pentzii* include P.I. 299749 and P.I. 299777. Two of 16 clones tested of *D. setivalva* are superior in resistance; i.e., P.I. 299791 and P.I. 299798. Twelve clones of *D. smutsii* were tested; P.I. 299811, 299826, and 299827 are superior in resistance. One of 30 clones tested of *D. valida* is superior in resistance; i.e., P.I. 299869.

TABLE 2.—*Resistance among* Digitaria *clones to the yellow sugarcane aphid,* Sipha flava *(Forbes)*

Species	USDA P.I. No.	Resistance rating[1]
D. milanjiana subsp. *eylesiana* Henr.	299703	3.6 a[2]
D. milanjiana subsp. *eylesiana* Henr.	299712	3.5 a
D. milanjiana subsp. *eylesiana* Henr.	299714	3.4 a
D. milanjiana subsp. *eylesiana* Henr.	299710	3.2 ab
D. milanjiana subsp. *eylesiana* Henr.	299708	3.1 ab
D. valida Stent	299869	2.7 bc
D. setivalva Stent	299791	2.4 cd
D. setivalva Stent	299798	2.2 cde
D. smutsii Stent	299827	2.0 def
D. pentzii Stent	299765	2.0 def
D. pentzii Stent	299741	1.9 defg
D. pentzii Stent	299752	1.8 defg
D. pentzii Stent	299766	1.8 defg
D. smutsii Stent	299811	1.8 defg
D. milanjiana (Rendle) Stapf	299655	1.6 efg
D. pentzii Stent	299769	1.6 efg
D. smutsii Stent	299826	1.3 fg
D. pentzii Stent	299749	1.2 g
D. pentzii Stent	299777	1.2 g

[1] Percentage infestation: 1 = 0–20%, 3 = 20–40%, 5 = 40–60%, 7 = 60–80%, 9 = 80–100%.

[2] Means are significantly different at 5-percent level by Duncan's Multiple Range if not followed by any letters in common.

Outstanding insect-resistant clones of each species were grouped and a statistical analysis made of their resistance ratings. No one clone is superior to all other clones (table 2). These data indicate clones of *D. milanjiana*, *D. pentzii*, and *D. smutsii* are superior in insect resistance to those of *D. milanjiana* subsp. *eylesiana*, *D. setivalva*, and *D. valida*. The superiority of germ plasm contained in *D. pentzii* is demonstrated by seven clones and that of *D. smutsii* by three clones (table 2). The resistance rating of 2.8 for Pangola grass, the control, is superior to the average performance of species (table 1) and intermediate among the more resistant clones (table 2).

A model was calculated for each species and for the mean of all species by stepwise regression. This model included: 1, rainfall in millimeters, 2, number of rainy days, 3, days in which rainfall was 12.9 to 25.4 mm., and 4, average temperature (C) for 28 days prior to rating as independent variables and the estimated resistance rating as the dependent variable. In these studies it was found that the number of rainy days was more important than rainfall. These studies show that the average temperature was important while rainfall in millimeters and days in which rainfall was 12.9 to 25.4 mm. contributed very little to the regression. The equation determined for the average behavior of species is:

$$Y = 32.253 - 0.179X_1 - 1.012X_2$$

Y = expected infestation rating; X_1 = number of rainy days during the 28-day interval before rating, and X_2 = average temperature (C) during the 28-day interval before rating. The coefficient of determination for this equation is 66.85 percent.

SUMMARY

Differential resistance to yellow sugarcane aphid, *Sipha flava* (Forbes), exists among *Digitaria* species. Differential resistance among species is expected on the basis of interspecific variation. Differential resistance to aphid damage exists among clones within species. Differences in insect resistance among clones within species are expected on the basis of intraspecific variation. Clones superior in insect resistance were delineated in this trial. The superior performance of phenotypes within species is masked by the average performance of the species.

Significant negative correlations were found between insect resistance ratings and the number of rainy days and average temperature during a 28-day interval prior to rating. A model was calculated for the average behavior of species; it includes infestation expected on the basis of the number of rainy days and average temperature during the 28-day interval before rating. The model accounted for approximately 66 percent of the variability present.

RESUMEN

Las distintas especies de *Digitaria* difieren entre sí respecto a su resistencia a los ataques del áfido amarillo de la caña de azúcar, *Sipha flava* (Forbes). Estas diferencias son de esperarse si se consideran las variaciones que existen entre las especies. Igualmente difieren entre sí los clones de una misma especie respecto a su resistencia a este áfido. En el caso de los clones de una misma especie estas diferencias también son de esperarse debido a que los clones varían igualmente entre sí. En esta prueba se hizo un análisis estadístico de los clones que demostraron su superioridad a este

respecto. El excelente comportamiento de los fenotipos en cada especie queda velado por el comportamiento medio de la especie.

Se encontraron correlaciones significativamente negativas entre los grados de resistencia al insecto y el número de días de lluvia y promedio de temperatura durante un intervalo de 28 días antes de la fecha en que se hizo la graduación. Se calculó un modelo representativo del comportamiento medio para cada especie; éste incluye el grado de infestación que puede esperarse basándose en el número de días de lluvia y promedio de temperatura durante un intervalo de 28 días con anterioridad a la fecha en que se hizo la graduación. El modelo explica aproximadamente al 66 por ciento de la variabilidad existente.

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